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MEADOWS *FOR* THE NORTHERN STATES



TIMOTHY AND RED CLOVER form the basis of hay growing on good soils in the northeastern one-fourth of the United States.

Alsike clover is better adapted to "sour" and moist soils than common red clover, and the two are often used on uplands mixed together to insure a stand.

Redtop is the best wet-land grass, but meadow fescue and timothy will thrive under fairly moist conditions.

A good wet-land mixture is redtop, meadow fescue, and alsike clover.

There are no good poor-land hay grasses. Redtop, orchard grass, and tall oat-grass will make a stand on soils of medium productivity, but it requires a rich soil for commercial hay growing.

The best temporary hay plants are the small grains, either alone or in mixture with some legume, such as peas, vetch, or crimson clover, or millets, Sudan grass, and coarse forages, such as corn or sorghum, seeded thickly.

Contribution from the Bureau of Plant Industry

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MEADOWS FOR THE NORTHERN STATES.

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THE AREA of tame-hay plants grown in 1909 in the region covered by this bulletin (fig. 1) aggregated 39,174,918 acres, according to the Bureau of the Census. The total yield that year was 50,594,171 tons. This area represents more than 83 per cent of the tame-hay acreage of the United States. Timothy alone or clover alone (mainly red and alsike clovers) and timothy and clover mixed constituted more than 88 per cent of the acreage of tame hay in this northeastern portion of the country. The cultural methods for timothy and clover are so well understood that they do not require the attention in this bulletin which their importance would seem to warrant.¹ These plants undoubtedly will continue to hold for many years



FIG. 1.—Outline map of the eastern United States, showing the region to which this bulletin applies.

¹ For additional information in regard to the culture of timothy, see Farmers' Bulletin 990, entitled "Timothy."

to come the popularity they now possess. While timothy and clover are the most profitable hay plants for most of this region, there are a number of other plants which, though not so well known, are more desirable for particular purposes or for certain conditions of soil and climate. These are referred to in this bulletin in the discussions of combinations of hay plants for special purposes. Hay plants may be classified as annual, biennial, and perennial, according to whether they live one, two, or more than two years. Millet, sweet clover, and timothy are examples, respectively, of these three classes.

PERMANENT, ROTATION, AND TEMPORARY MEADOWS.

Meadows may be considered as permanent, rotation, and temporary, depending on the length of the period during which they are allowed to grow before tilling the land. Permanent meadows are those that are kept in grass indefinitely and are mowed for hay. There are few such meadows in the northeastern portion of the United States except those on bottom lands and in localities where the production of other crops has become economically unprofitable. Lands that are occasionally subject to overflow often make splendid permanent meadows. In most cases, however, it is more profitable to plow the land every two or three years and reseed. Most hay plants make their maximum yields the first and second years after seeding. After that they tend to deteriorate and the yields are diminished. Alfalfa, orchard grass, redtop, meadow fescue, and alsike clover are some of the best plants for permanent meadows.

Rotation meadows are those that are seeded in regular crop rotations and are usually left for two or three years. The common rotations, such as the well-known 4-year rotation of corn, wheat, and two years of hay and the equally well-known 5-year rotation of corn, oats, wheat, and two years of hay, are applicable to this entire region. The greater part of the market hay is produced by farmers practicing these rotations. Timothy, red clover, perennial rye-grass, and orchard grass are suitable for rotation meadows.

Temporary meadows are those used for hay but one year. They are seeded to some quick-growing crop. Millet, red clover, Sudan grass, Italian rye-grass, and the cereals make good temporary hay plants.

PLANT MIXTURES FOR MEADOWS ON FERTILE WELL-DRAINED SOILS.

There is little difference of opinion as to the plants to be seeded on rich well-drained land. Timothy is seeded alone when the hay is to be sold on the market, and timothy and clover, often mixed with redtop, where part or all of the hay is utilized on the farm. The long period during which these two plants—timothy and red clover—have

held their popularity as hay plants in this region precludes the likelihood of their being superseded in the near future by any others. Some of the reasons for the popularity of these plants may be stated briefly: They have good seed habits, especially so in the cases of timothy and redtop, and the seed is obtainable in large quantities; red clover is a deep-rooted legume and has a beneficial effect on succeeding crops; timothy is considered by feeders the best hay for horses; and clover or clover and timothy mixed are excellent for cattle and sheep. They make heavy yields of hay. The comparatively long period during which these plants may be left standing without serious deterioration before cutting, together with the fact that the time of maturity of these plants interferes little with the harvesting of the cereals and other farm work, have much to do with their popularity. The most serious objection to their culture is due to the differences in the time of their maturity. Red clover is ready to cut about two weeks before timothy is mature. Mammoth clover, a variety of the common red clover, is somewhat later in maturing and is often used in place of red clover in mixture with timothy. In practice, the difference in the time of maturity is not such a serious fault as it might seem. Red clover greatly predominates the first year after seeding and should be cut when in full bloom. By the second year much of the clover has died out and the timothy may be allowed to reach the proper stage before cutting. Whether it is best to use redtop in this mixture depends mainly on the purpose for which the hay is grown. Hay buyers will usually discriminate against timothy hay that has an admixture of redtop. Although redtop is not so palatable as timothy, there is not the difference in the feeding values of these two grasses that their market prices would indicate. If the hay is to be consumed on the farm it is probably advisable to include a small proportion of redtop when seeding. The addition of redtop will add somewhat to the total hay produced and will not crowd out the other plants to any great extent.

Owing to the increasing difficulties of getting stands of red clover in the older farming sections many farmers are using mixtures of alsike and red clovers instead of red clover alone in the above mixture. This practice gives an added insurance against the failure of the stand and is to be recommended wherever success with red clover is uncertain. It must be borne in mind, however, that the growth of alsike clover on dry uplands is small.

MIXTURES FOR POORLY DRAINED FERTILE LANDS.

It is impossible to succeed with any of the common tame grasses on lands which are water-logged. An occasional overflow does little damage to the stand of grass unless water remains for several days or there is a large deposit of mud from the water.

There are three good wet-land plants besides timothy which will tolerate considerable moisture.

The best grass for such conditions is redtop. If the land is too wet for redtop there is little use of seeding anything. Reed canary grass (*Phalaris arundinacea*) and wild rice (*Zizania aquatica*) might be used, but the seed of both is expensive. The legume which will do best on moist lands is alsike clover. This makes a good growth and is in every way as desirable for the conditions under which it thrives as red clover is for well-drained soils. Meadow fescue is another grass which does well on moist lands. All the other tame grasses succeed much better on well-drained soils.

The following mixture is suitable for moist meadows, the quantities specified being the rate to seed per acre: Redtop, 8 pounds; alsike clover, 6 pounds; meadow fescue, 14 pounds. In case the lands are not very wet 10 pounds of timothy may be substituted for the meadow fescue. It is customary with lands of this character to keep the fields permanently in grass, and in that case it will be desirable to use both the meadow fescue and timothy at the rate of 10 and 6 pounds, respectively.

MIXTURE FOR THE SOUTHERN BORDER OF THE TIMOTHY BELT.

There are many soils along the southern border of the area under discussion which will give a larger hay crop if seeded to orchard grass, tall oat-grass, and alsike clover than if seeded to the timothy, redtop, and red-clover mixture. These soils are usually poor in organic matter and are inclined to be "sour." Orchard grass, tall oat-grass, and alsike clover all mature at about the same time and nearly two weeks earlier than timothy. This mixture must be cut when the plants first head out or it will make a tough, less palatable hay. This is especially true of orchard grass. If cut early the hay will be relished by all classes of live stock. Common red clover may be substituted for alsike clover on good uplands, but a mixture of the two is more likely to give a stand than either alone under such conditions. For general use the Arlington mixture is recommended: Orchard grass, 14 pounds; tall oat-grass, 12 pounds; alsike clover, 6 pounds per acre.

POOR-LAND HAY PLANTS.

Raising hay on poor land is not satisfactory. It is, however, sometimes necessary to make the attempt. The orchard grass, tall oat-grass, and alsike mixture is perhaps the best for poor clay lands. In some places in the Middle West sweet clover is giving good results under unpromising soil conditions. There are no perennial hay plants that will produce well on poor sandy soils. Tall oat-grass and redtop

will usually catch, but will scarcely produce a hay crop. Some temporary crop, such as rye or oats and peas, should be used under such conditions. Early sorghums and cowpeas are often used along the Atlantic coast and will make a very good hay for home use. They are, however, difficult to cure. No one should make a practice of growing hay for market on poor land.

TEMPORARY HAY PLANTS.

There are a number of quick-growing plants which make hay of fair quality. Among these plants are all of the small grains. When the price of grain is low enough to justify the practice, oats, wheat, barley, and rye may be made into hay. Rye should be cut when it first heads or it may become too tough for stock to relish. A delay of a few days makes a marked difference in this respect. The other cereals may be allowed to stand a little longer, but they should be cut by the time the seed is in the milk stage.

In the Northern States a combination of oats and Canada field peas makes a very good hay crop. It should be seeded as soon as the soil can be worked in the spring. Varying mixtures of these two plants are used. A common one is made up of $1\frac{1}{2}$ bushels of oats and 1 bushel of peas to the acre. The two kinds of seed may be mixed together and seeded with a grain drill. A more evenly mixed stand, however, will be obtained if they are seeded separately. Some broadcast the peas before plowing and turn them under with a turning plow. The oats are then seeded in the usual manner. Where this method is practiced, the plowing should be not more than 5 or 6 inches deep. Some put the peas in first, running the drill so as to put the seed at least 4 inches below the surface, and then broadcast the oats about a week later and harrow them in. Heavy rains after seeding the peas may prevent the successful operation of this method.

Millet is often used for a temporary hay crop. The fact that it may be seeded after a failure of corn or some other spring-seeded crop or after it is certain that the regular hay crop will be short makes millet of great value. The common or Hungarian variety should be used in the northern part of the timothy belt and the German in the southern. Japan millet does well in New England. Millet may be seeded at any time after corn planting up to July. The last seeding should allow at least 60 to 70 days before it is time for a killing frost. The rate of seeding for millet in this region is usually from 25 to 30 pounds to the acre.

A combination of plants which has given excellent results in eastern Maryland and Virginia is winter oats, hairy vetch, and the white-blooming variety of crimson clover. This white-blooming variety is about two weeks later in maturing than the common crim-

son clover and fits in better in this mixture. The vetch should be inoculated if the land has not grown vetch previously. A good mixture of these seeds will be—

	Per acre.
Oats.....	1 bushel.
Hairy vetch.....	30 pounds.
White-blooming crimson clover.....	10 pounds.

Sudan grass alone or in combination with an early variety of cowpeas or soy beans makes an excellent temporary hay mixture for the country south of Pennsylvania.

TIME AND METHOD OF SEEDING.

The customary method of seeding grasses and clover with a small grain has some advantages and also some disadvantages. The main thing in favor of the practice is its cheapness, one preparation of the seed bed answering for seeding both the grass and the grain. The disadvantages are the uncertainty of getting a stand, the liability of winterkilling if seeded late in the fall, and the great abundance of weeds which become established in the meadow.

The usual method is to seed such grasses as timothy, orchard grass, or redtop with wheat or rye in the fall and then to sow clover on the field late in the winter or early in the spring. Considerable grass and clover is seeded with oats or barley in the spring. There are several serious faults in these methods. The best time for seeding wheat or rye in the fall is too late for safe grass seeding. The young grass plants do not grow as rapidly as the grain and often do not get sufficiently rooted to survive the winter. Many soils run together and become so hard on the surface that clover seeded in the spring has no opportunity to become established. This is obviated to some extent by harrowing the grain with a spike-tooth harrow just before seeding the clover. It is impossible to estimate the quantity of clover seed wasted every year by seeding on hard-packed soils, but it is safe to say that it is a large percentage of the total sown.

The stand of grass is lessened by the space occupied by the grain. Sometimes a good stand of grass results from seeding with grain, but it is seldom that the perfection of stand for which one should strive is obtained. The term "nurse crop," which is often applied to a grain crop when it has grass seeded with it, is a misnomer. The grain does not act as a nurse for the grass in any sense of the word. There is the sharpest kind of competition among the plants for food, moisture, and sunlight. This may be better appreciated when the fact is taken into consideration that the grass if seeded alone in the fall would be ready to cut for hay by the time wheat is ripe, but it requires another year to produce a crop when seeded with the grain.

On some of the best grass soils of the corn belt timothy seeded in the fall with wheat makes sufficient growth to become detrimental to the yield of grain. Some farmers attempt to avoid this injury by sowing only a portion of the timothy seed in the fall and the remainder with the clover in the spring.

Many stands of grass are injured and sometimes destroyed in the two or three weeks following the harvesting of the grain. The young tender grass plants which have developed in the shade of the grain are exposed to the sun at the hottest time of the year. Summer weeds also have the opportunity to smother out some of the grass, as they make their best growth during the hot weather.

SEEDING WITHOUT A GRAIN CROP.

It may be said for seeding alone in late summer or early fall that it nearly always results in a better stand, the crop of hay is obtained as soon as if it had been seeded in a grain crop 10 months before, the grass is much freer from weeds, and usually there is a higher yield.

Spring seedings do not usually give as satisfactory results as those of late summer. This is largely due to the encroachment of weeds. Spring seedings of grass also involve a loss of the use of a field for an entire season. It is possible to harvest a crop of grain, then seed to grass, and get the hay crop as soon as it would have been obtained by seeding in the spring. Few of the hay grasses except the millets and Sudan grass will produce a crop of hay the same season they are sown. The rye-grasses are among the most rapid growers of the hay plants, but these will rarely produce a good crop the first season if seeded in the spring.

PREPARATION OF THE SEED BED.

In order to avoid losing the use of the land for an entire season and to allow for late-summer or early-fall seeding, the grass usually follows some small grain. The seed bed should be prepared as soon as possible after the grain is harvested. This preparation is best done with a disk harrow. Plowing deeply during that period is not desirable. There is not sufficient time before seeding to get the stirred soil compacted and united with the subsoil to allow the rise of moisture from below. A 3-inch mellow seed bed with firm soil beneath will give better results for summer seeding than one that is deeper. If the soil is so hard that it is impossible to cut it up with a disk harrow, it may be plowed shallow with a turning plow. A method used at the Tennessee Agricultural Experiment Station is to break the surface with a subsoil plow, making the plow furrows $2\frac{1}{2}$ to 3 feet apart. This loosens the soil sufficiently to allow a disk harrow to work effectively.

Most grass seeds are very small and must have a fine, mellow soil in order that the seedlings may become established.

RATE OF SEEDING.

Rich land with a well-prepared seed bed does not require as much grass seed as thin land or land poorly fitted for seeding. From 5 to 10 pounds of grass seed to the acre evenly distributed would give an abundance of plants if every seed produced a plant. In practice, however, some of the seed fails to grow. This may be due to poor germination or faulty covering of the seeds, some being left on the surface and others buried too deeply. Most farmers use too little grass seed for the best results. From 20 to 30 pounds of seed per acre are generally sufficient, and this rate is usually more profitable than lighter seedings of mixtures. The size of the seed makes considerable difference as to the rate to use. Small-seeded grasses, such as redtop and timothy, do not require so heavy a seeding as orchard grass or rye-grass. Usually 10 pounds of timothy or 6 pounds of redtop are sufficient where these are seeded alone.

FERTILIZERS.

Hay crops respond very quickly to proper fertilization. There has been a decided change in the opinion of farmers and investigators in late years as to the crop in a rotation which should be fertilized. Formerly the grain crop received the fertilizer, and the residues left in the soil were supposed to be sufficient for the grass crop. Experimental evidence indicates that corn following a grass crop which has been fertilized will yield as well as, if not better, than when the same quantities of fertilizers are applied directly to the corn. Even highly soluble quick-acting fertilizers, like nitrate of soda, applied to a grass crop will sometimes show beneficial effects on succeeding crops for two or three years. These results may be explained by the greater accumulation of organic matter in the soil, due to the fertilization. It is a well-known fact that grass plants, with their enormous fibrous root systems, are highly efficient in maintaining the supply of vegetable matter in the soil.

FERTILIZERS RECOMMENDED.

Top-dressings of stable manure will increase the yield of hay. There is probably no better crop than grass on which to apply the manure. The usual method is to scatter the manure during the fall and winter after one crop of hay has been cut from a field. There are several good reasons for this practice. The danger of injury to the texture of the soil from driving on the field is lessened. There is less danger from introducing weeds, carried by seeds in the manure,

to an old seeding than to a new one. The grass plants have become better established at the end of one season's growth and will make their maximum yield the second year if the soil is enriched.

Some commercial fertilizers will usually return a good profit when applied to the hay crop, but they should be used with some caution. It is a waste of money to apply nitrogenous fertilizers, such as nitrate of soda, sulphate of ammonia, dried blood, or cottonseed meal, to a clover crop or to a hay crop containing a high percentage of clover. These fertilizers, however, applied as a top-dressing in the spring, when growth first starts, to the second season's crop, when most of the clover has died out, will usually pay. At the Virginia Agricultural Experiment Station nitrate of soda returned a profit from its use when applied as heavily as 250 pounds per acre to a timothy-redtop-clover meadow from which hay had been cut one year. These fertilizers do not give equally good results when the meadow is 2 or 3 years old, probably because of the poorer stand and weakened vitality of the plants.

It is usually considered more profitable to apply phosphatic fertilizers to the crops preceding the hay than directly to the latter. In the customary rotation of corn, wheat, and hay the phosphates will give the best results when applied to the wheat crop. The effects of phosphorus continue for several years and benefit the hay crop as well as the wheat. There are such wide differences in the results obtained by different experimenters from the use of fertilizers that each farmer should consult his State experiment station before investing in these materials.

USE OF LIME.

A great deal of grass and clover seed is wasted every year from seeding on "sour" soils grasses and clovers, which will not thrive under such conditions. A large proportion of the lands in the older farmed sections have become poor in organic matter and have developed a condition commonly spoken of as "acid." The exact chemical nature of this condition is not so well understood as is the remedy. Lime has been found to correct this condition, so that many crops, like red clover and alfalfa, will grow after liming where they would not grow previously. The use of lime as a soil amendment has been practiced by farmers for several centuries. More than a hundred years ago it was known to benefit certain crops. In many farming communities in England and in some in this country it has been customary to lime the land regularly every six or seven years.

Lack of lime or an "acid" condition of the soil is not adverse to all plants. Redtop, Rhode Island bent, the fescues, and alsike clover will thrive provided the soil is sufficiently rich even when too "sour"

for most other hay plants. Where it is not practicable to use lime and the soil is "sour" the above plants should be used.

Agricultural lime is found on the market in three forms: Burned lime, hydrated lime, and carbonate of lime. The consensus of opinion of most investigators of the subject is that it makes no difference which of these forms is used provided the same quantity of calcium, the essential element, is added in each case. Theoretically, 56 pounds of burned lime is equal to 74 pounds of hydrate of lime or 100 pounds of carbonate of lime. The carbonate of lime is usually the ground limestone, and it is often much cheaper than the other forms. When 2 tons of ground limestone can be applied for the same cost or less than it would take for 1 ton of burned lime, the former is preferable. When burned lime is used it should be applied at least two weeks before seeding.

Certain plants show clearly whether or not lime will be beneficial. Where red clover grows luxuriantly it is an indication that the land is not "sour" and will probably not give profitable returns for an application of lime. The quantity of lime needed depends on the degree of "acidity" of the soil. Ground limestone at the rate of 1 or 2 tons to the acre or its equivalent in burned or hydrated lime is the usual application.

The available evidence does not warrant the use of lime as a top-dressing on an established meadow. It should be thoroughly incorporated with the soil when it is being prepared for seeding the grass or for some preceding crop.

COMMON HAY PLANTS.

The following list includes most of the important hay plants for the northeastern part of the United States, gives in extremely brief form their chief characteristics, and points out their use. There are some plants which would be valuable hay plants if they were not so troublesome as weeds in cultivated fields. Others possess value but are inferior to the common better known species, so there is no particular reason for growing them.

Timothy.—A perennial and very valuable hay plant, too well known to require a description.

Red clover.—A biennial tufted plant, sometimes called the farmer's best friend. Makes a heavy growth on fertile well-drained soils. Not suited to wet or "sour" conditions. Benefits succeeding crops and makes a nutritious hay. Usually gives a light second crop in the fall.

Mammoth or sapling clover.—A large, coarse variety of red clover. Is ready to cut about two weeks later than common red clover and so combines well with timothy. Does not produce an aftermath.

Alsike clover.—A perennial clover which does best on moist soils. Will also grow on some soils which are too "sour" for red clover. Often used in mixtures with red clover to insure a stand. Makes a hay of good quality.

Orchard grass.—A coarse, tufted perennial grass. Will stand more shade than any other tame-hay grass. Makes good hay when cut young. Mature plants are tough and unpalatable.

Redtop.—A creeping perennial which will thrive under a great variety of conditions of soils and climates. It is the best wet-land hay grass and is sometimes used as a sand binder. Makes a fair quality of hay when cut early. Mature plants are wiry and undesirable. Hay buyers discriminate against redtop.

Alfalfa.—A most valuable perennial hay plant where it can be grown profitably. It produces three or four cuttings a year.

Tall oat-grass.—A tall-growing tufted perennial which possesses considerable merit for poor sandy soils. Makes a hay of good quality. It is not a heavy yielder.

Perennial rye-grass.—A tufted perennial which makes a vigorous growth while young. Does not yield sufficiently to be of much value as a hay plant.

Italian rye-grass.—A tufted annual or short-lived perennial, similar to perennial rye-grass but coarser and more valuable as a hay plant. It is better suited to the southern part of the timothy belt than to the northern part.

Millet.—A quick-growing heavy-yielding annual, suitable as a catch crop for hay. Needs a rich soil.

Cereals.—All the small grains make a fair quality of hay if cut early.

Oats and field peas.—These plants in combination are much used in the Northern States for hay, but are not adapted to the region south of Pennsylvania and Ohio.

Sudan grass and cowpeas or soy beans.—All of these make a good annual hay crop in the southern portion of the timothy region.

